Preliminary results of linear stability analysis on the onset of convection in a thick rotating spherical shell with implications for a dynamo in an icy moon

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Convection in the fluid core of a terrestrial planet, which maintains its intrinsic magnetic field by dynamo action, is driven by thermal and/or chemical buoyancy. In case of the Earth, the former is fed by secular cooling of the core, latent heat release upon inner core solidification, and possibly decay of radioactive elements in the core, while the latter arises from light element ejection into the outer core at the front of inner core growth. On the other hand, let us consider a celestial body smaller than the Earth. In that case, compositional convection could occur in various ways due to different pressure-temperature conditions, strongly depending on bulk sulfur content in the core. Among them, we here focus on the iron snow process, which might drive the present Ganymede’s dynamo.

In order to understand a basic flow structure of convection driven by the iron snow process, onset of thermal/compositional convection in rotating spherical shells is studied with linear analysis. First, we consider thermal convection of a Boussinesq fluid contained in a rotating spherical shell. We solve the linearized equations as an eigen-value problem, and then, check validity of our linear code by comparing the results with those in a literature (Ardes et al., 1997). Thus, the Ekman number adopted here is not very low, . Afterwards, linear stability problem of compositional convection driven by iron snow is examined. In this case, relative inner core size smaller than the Earth is given to mimic possible Ganymede’s core geometry. Using the results, we then solve kinematic dynamo problem to gain some insights into dynamos driven by iron snow. We will report our preliminary results about these issues.

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